ArgoNeuT

One MIP Hit Shape Fitting

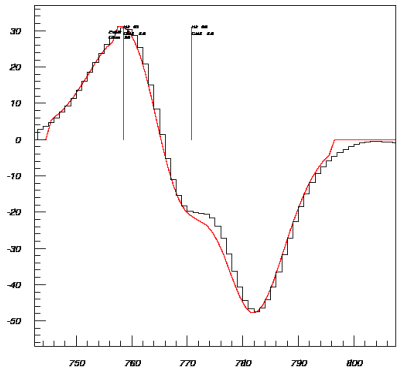
Bruce Baller

ArgoNeuT

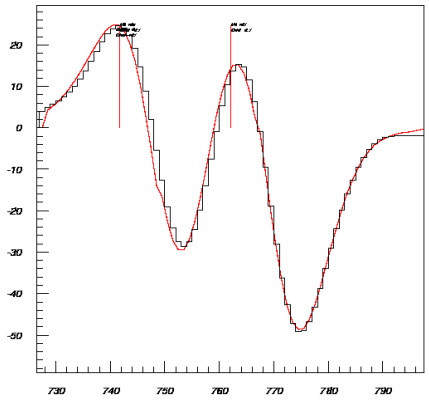
Goals

- Determine the minimum number of shapes required to fit hits on tracks with varying angles
- Determine double hit separation
  - Close double hits are identified by poorly fitting single hit shapes

Strong coupling



Obvious double hit



ArgoNeuT

Simulation & Offline

- Generate 200 10 GeV muons with a random distribution in spherical coordinates
  - $\theta < 80^{o}$
  - $0 < \phi < 2\pi$
- Use ArgoNeut electronics simulation

- FFT de-convolution with sigmoid filter
- Require 1 MC track (no δ rays, interactions)
- Do not fit double hits
- Hit fit weighting factor = 1/(5 * ADC noise^2)

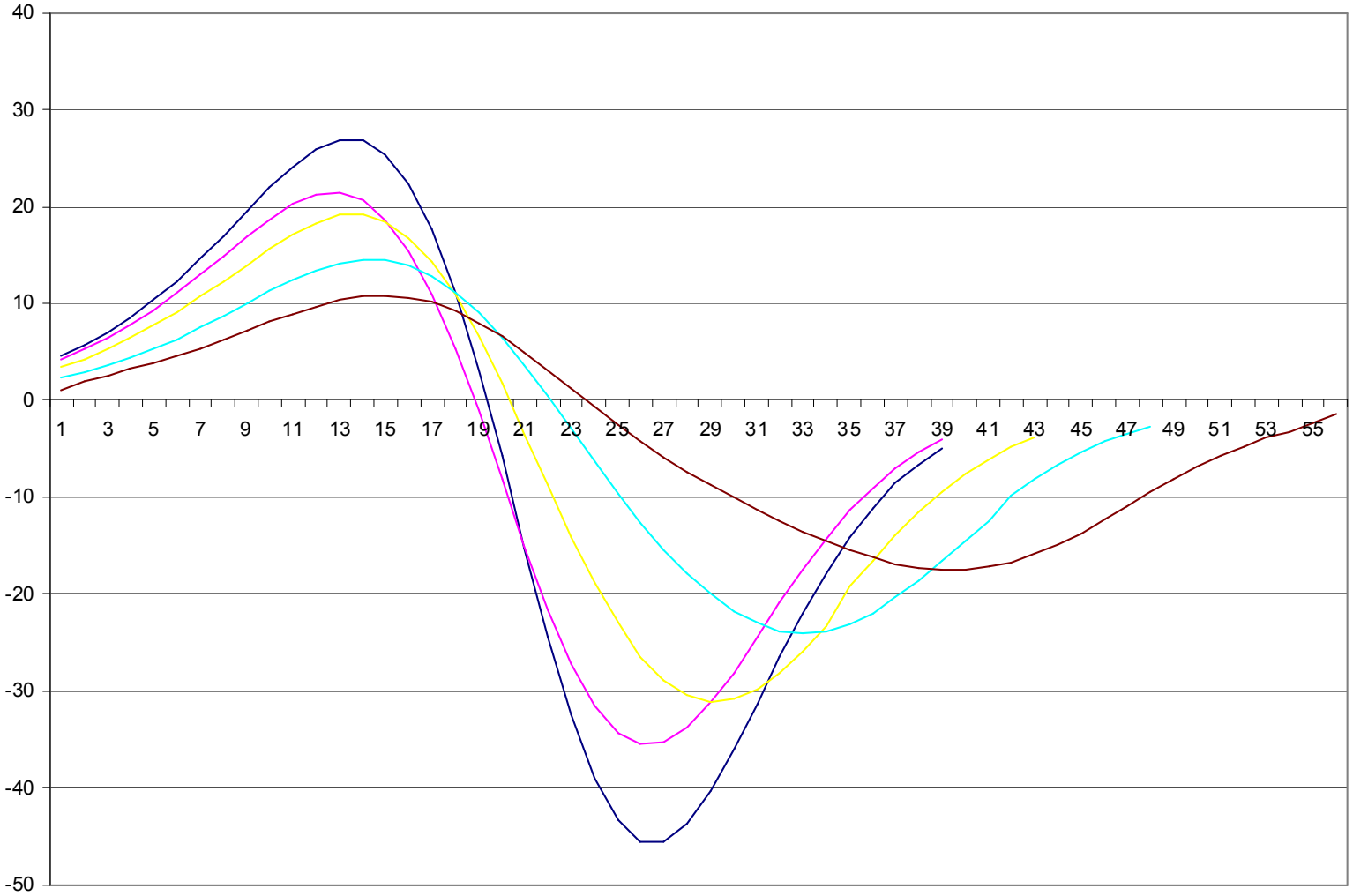
ArgoNeuT

Generating Hit Shapes for the Library

- Select an event with a single 1 MIP track with the desired dip angle
  - "dip angle" = angle relative to the wire plane
- Select a block of ADC channels in each view
  - Chan(50) – Chan(90) in the U (induction) view
  - Chan(335) – Chan(375) in the V (Collection) view
- Use the ADC shape in Chan 50 and 335 as the (temporary) library shapes
  - Ensure pulse heights consistent with ~1 MIP
- Fit channels 51 – 90 and 336 - 375 using these shapes
  - Use channel for averaging the pulse shape if
    - Good χ^2 , MIP's < 2, hit position OK
- Determine U & V track slopes & correct the averaged shape amplitude for the wire cell path length
- Transfer averaged pulse shape into the shape library
  - Create a shape flag (1,2,3…) = dip angle (degrees) / 10
    - Except dip angle = 0 has shape flag = 1

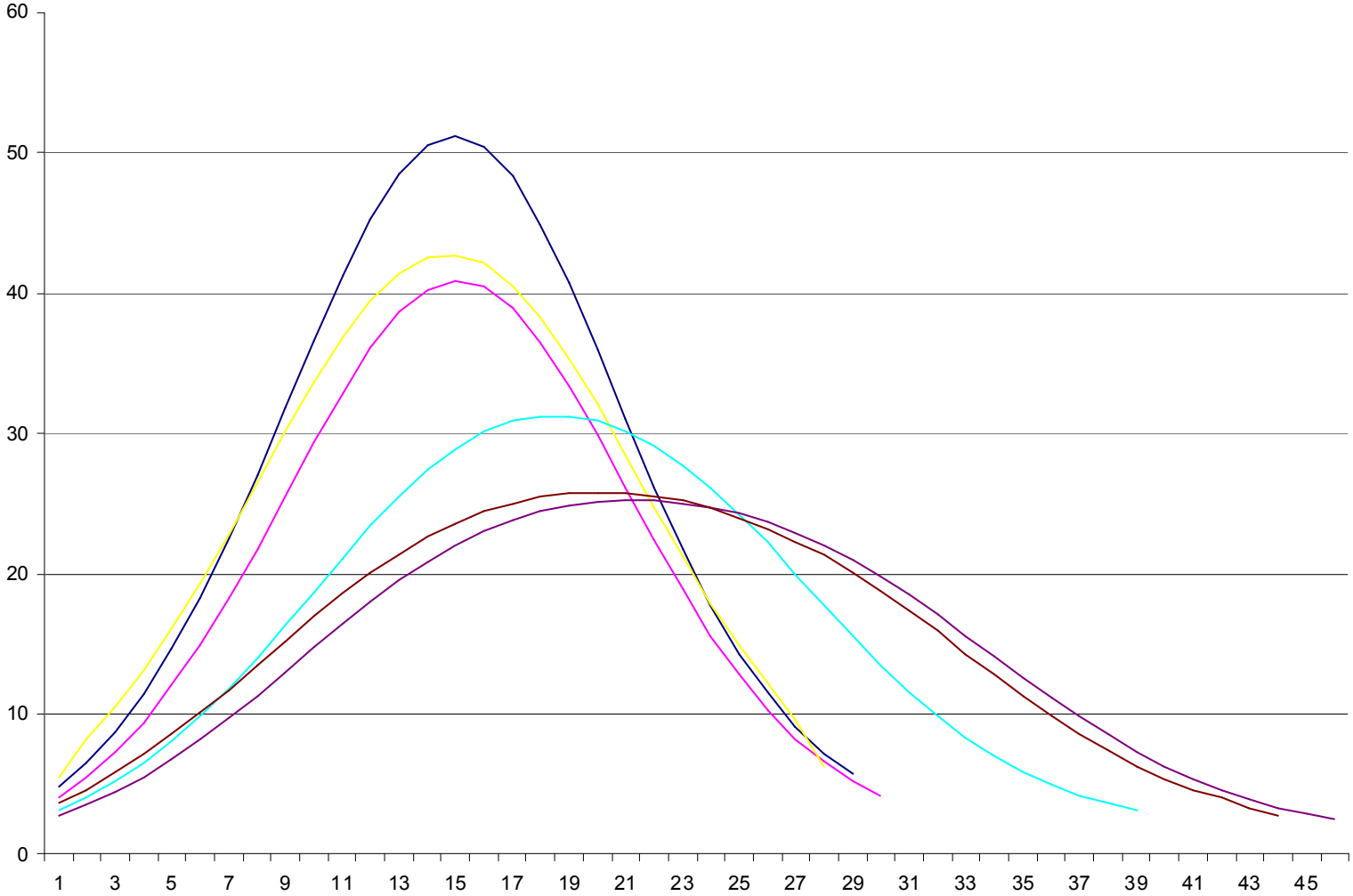
ArgoNeuT

Induction Plane Shapes



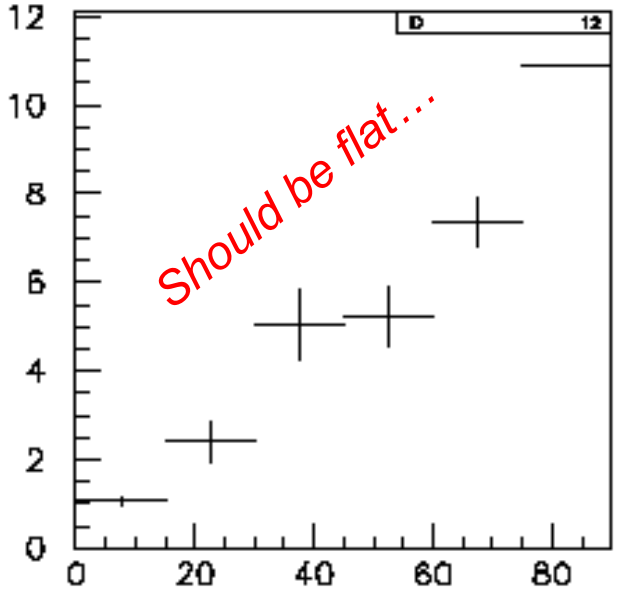
ArgoNeuT

Collection Plane Shapes

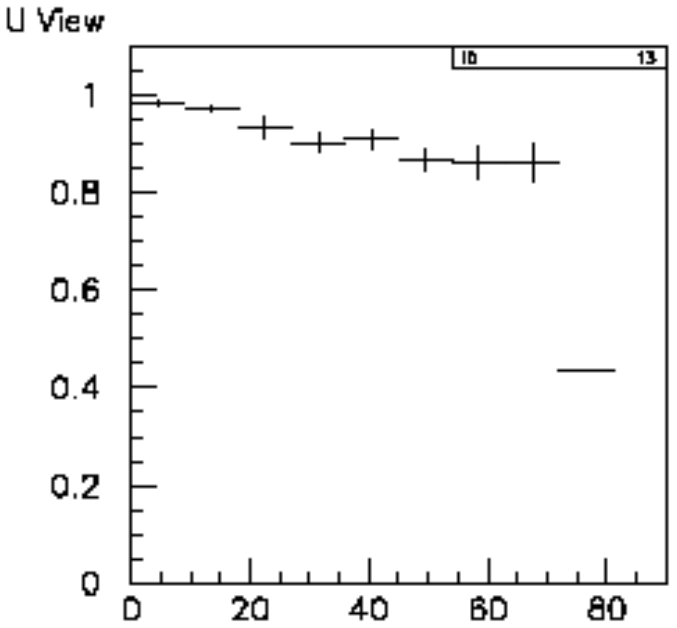


ArgoNeuT

Induction Plane

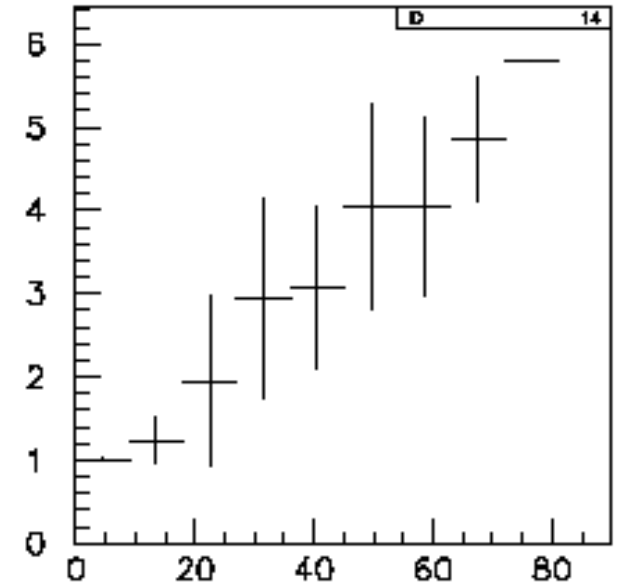


U Reco clstr chi vs dip

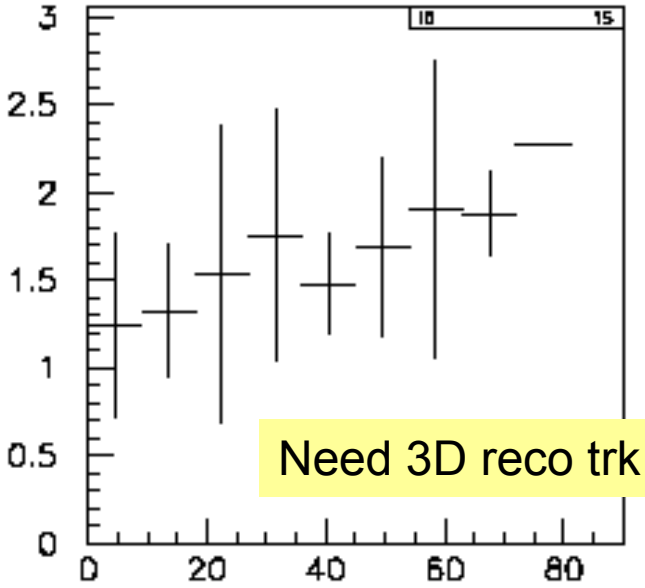


U Reco clstr hit eff vs dip

Nice correlation between dip angle and the shape flag



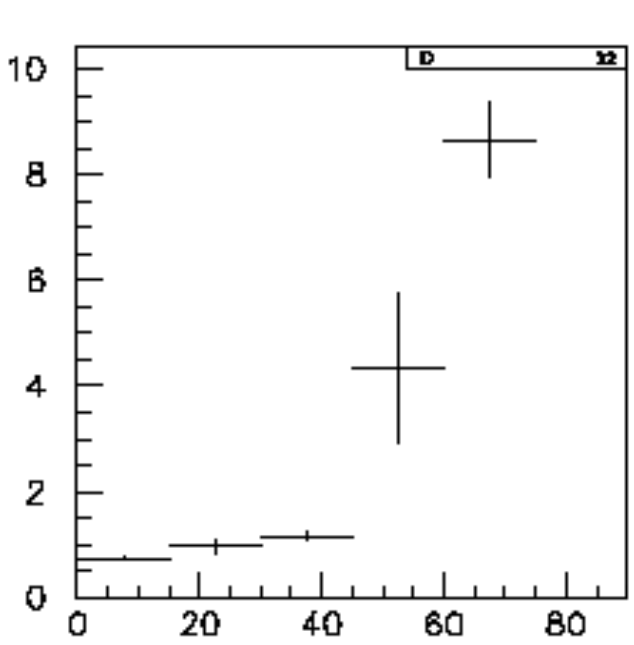
U Reco clstr flag vs dip

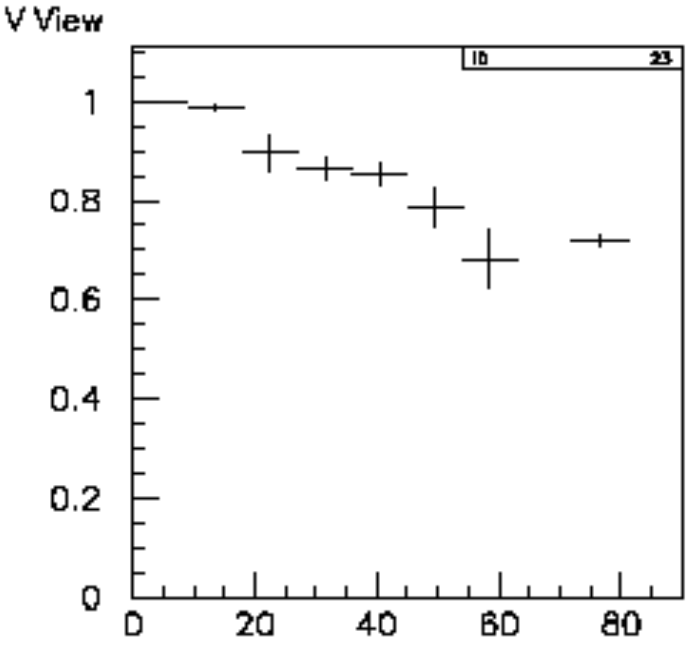


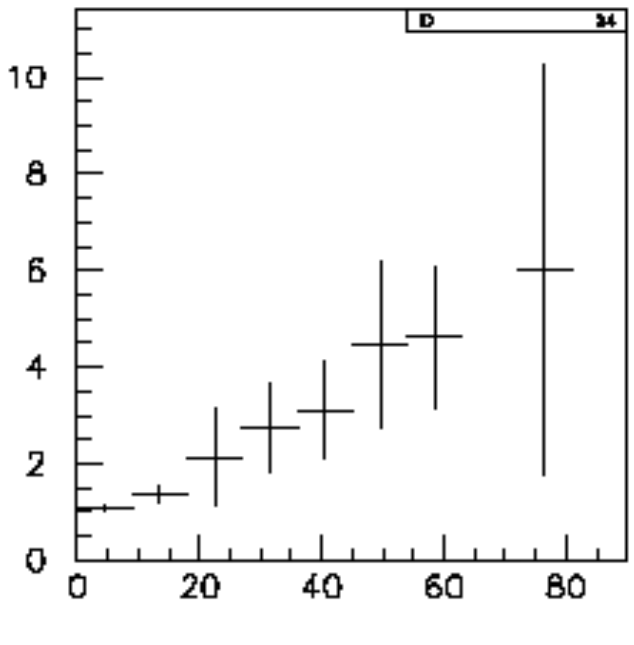
U Reco MIPs vs dip

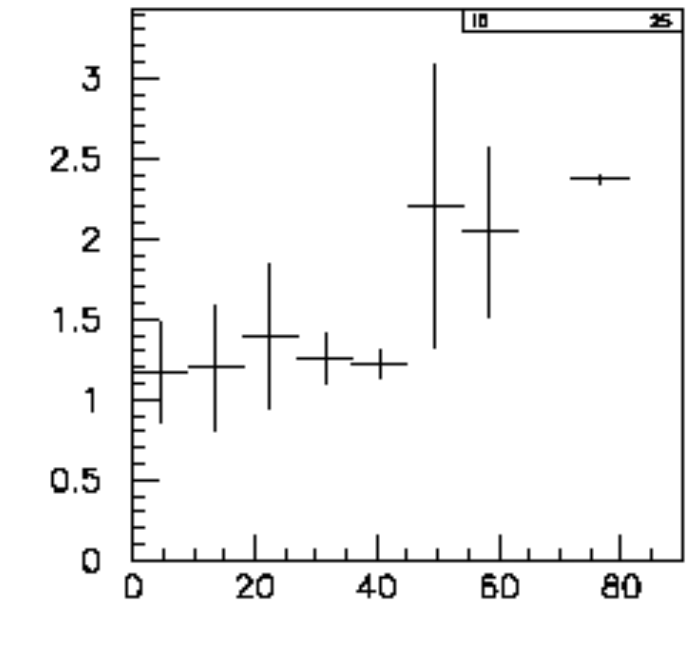
ArgoNeuT

Collection Plane









ArgoNeuT

Induction Plane Shape Flag vs Track Angle

True track angle

Reco fit failed or χ^2/dof > 20

Reco Shape Flag ~ Track Angle/10

	1	2	3	4	5	6	10
10	95%	4%					1%
20	57%	39%		2%			1%
30	15%	66%		13%	4%		2%
40		53%		29%	3%		15%
50	1%	22%		61%	6%	3%	7%
60		10%		32%	26%	5%	27%
70					20%	7%	72%
80					5%	17%	78%

Most large angle “failures” (Flag=10) will be inaccurately recovered by fitting double (small angle) hit shapes – *lose information on the ionization*.

Should increase the number of large angle hit shapes

ArgoNeuT

Collection Plane
Shape Flag vs Track Angle

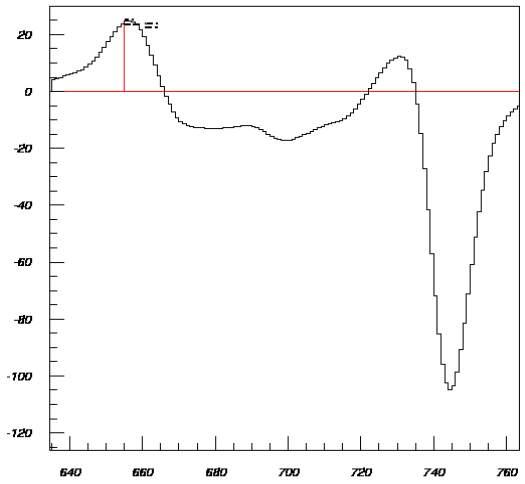
True track angle

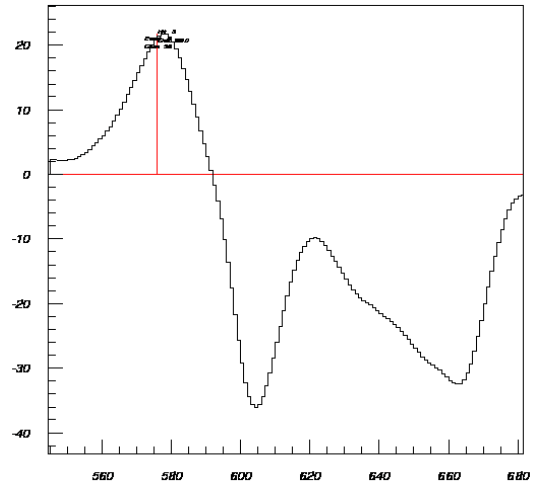
Reco Shape Flag ~ Track Angle/10

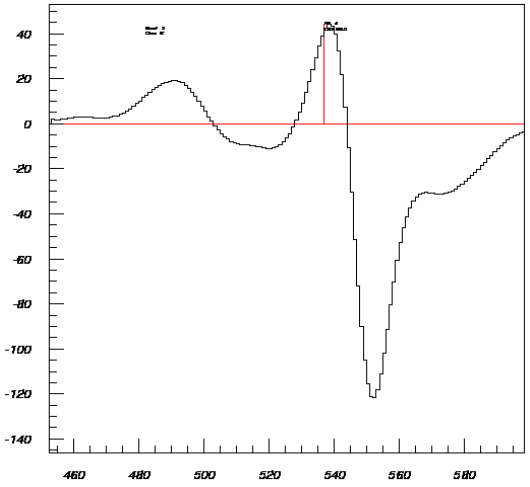
	1	2	3	4	5	6	10
10	76%	14%					10%
20	40%	43%		2%			15%
30	10%	46%		27%			17%
40	6%	18%		52%		1%	23%
50	3%	5%		14%		8%	70%
60		6%		11%	2%	11%	70%
70						21%	79%
80							100%

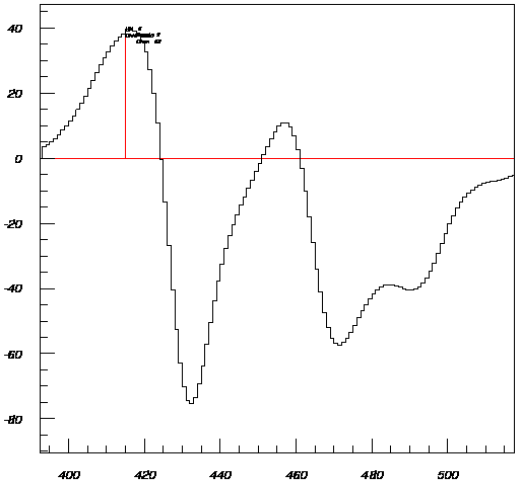
ArgoNeuT

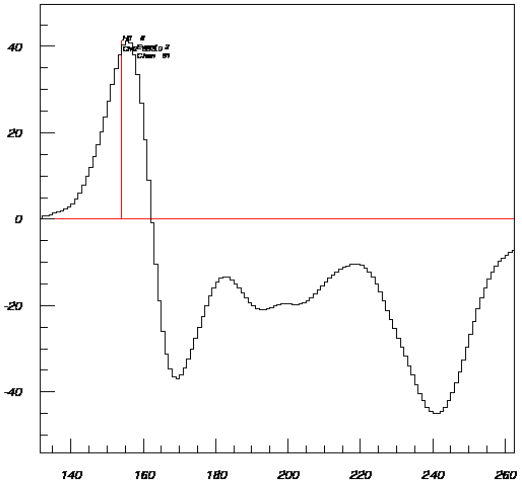
80^{o} Dip Angle Track Induction Plane Hits

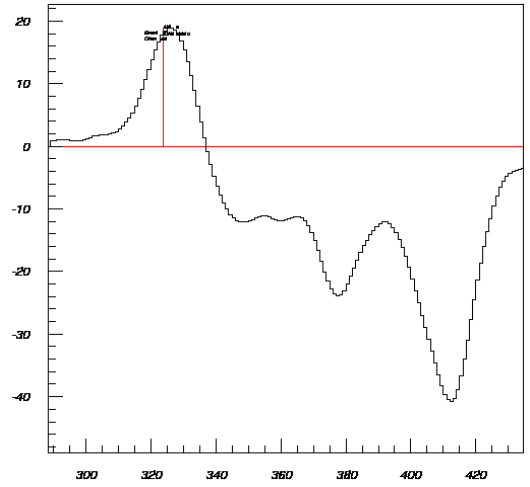








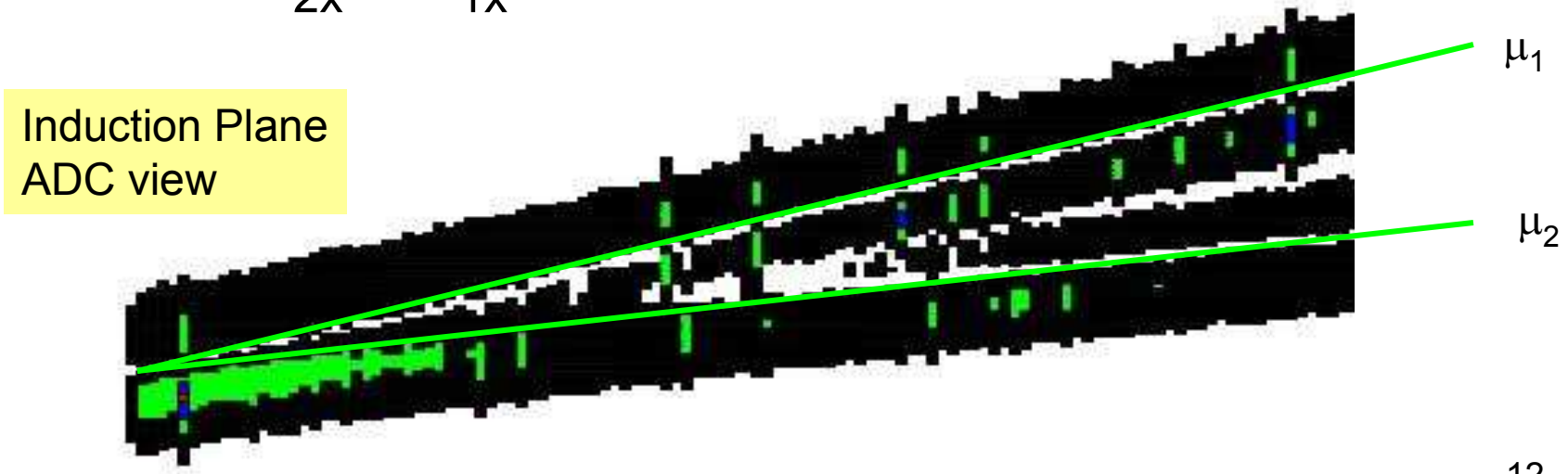




ArgoNeuT

Double Hit Study

- Generate 100 events with
  - A 10 GeV muon with origin at (0,0,10) and $\theta_1 < 0.2$
  - A 2nd 10 GeV muon with origin at (0,0,10) and $\theta_{2x} = \theta_{1x} + 0.02$



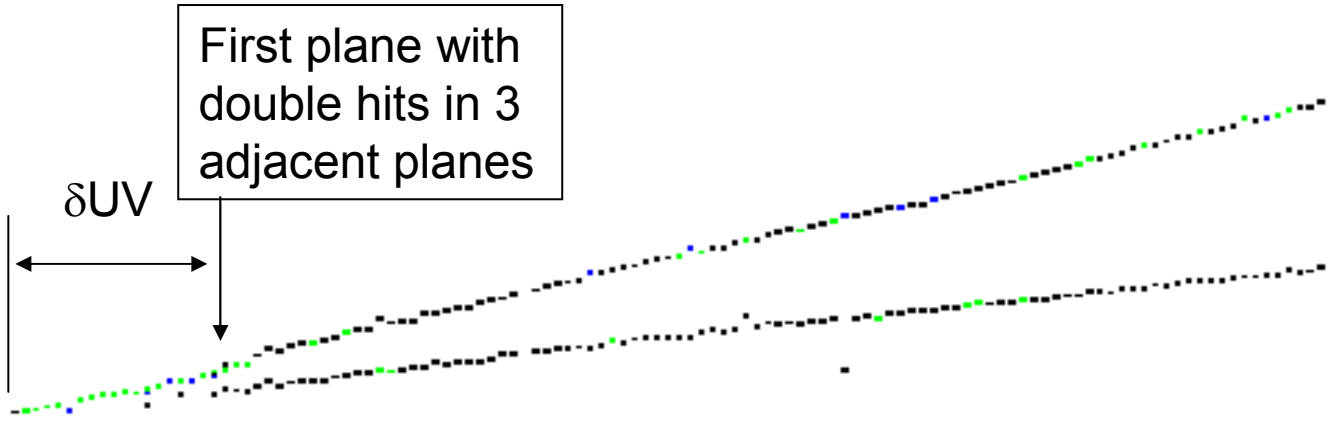
ArgoNeuT

Multi-Hit Reconstruction
Induction Plane

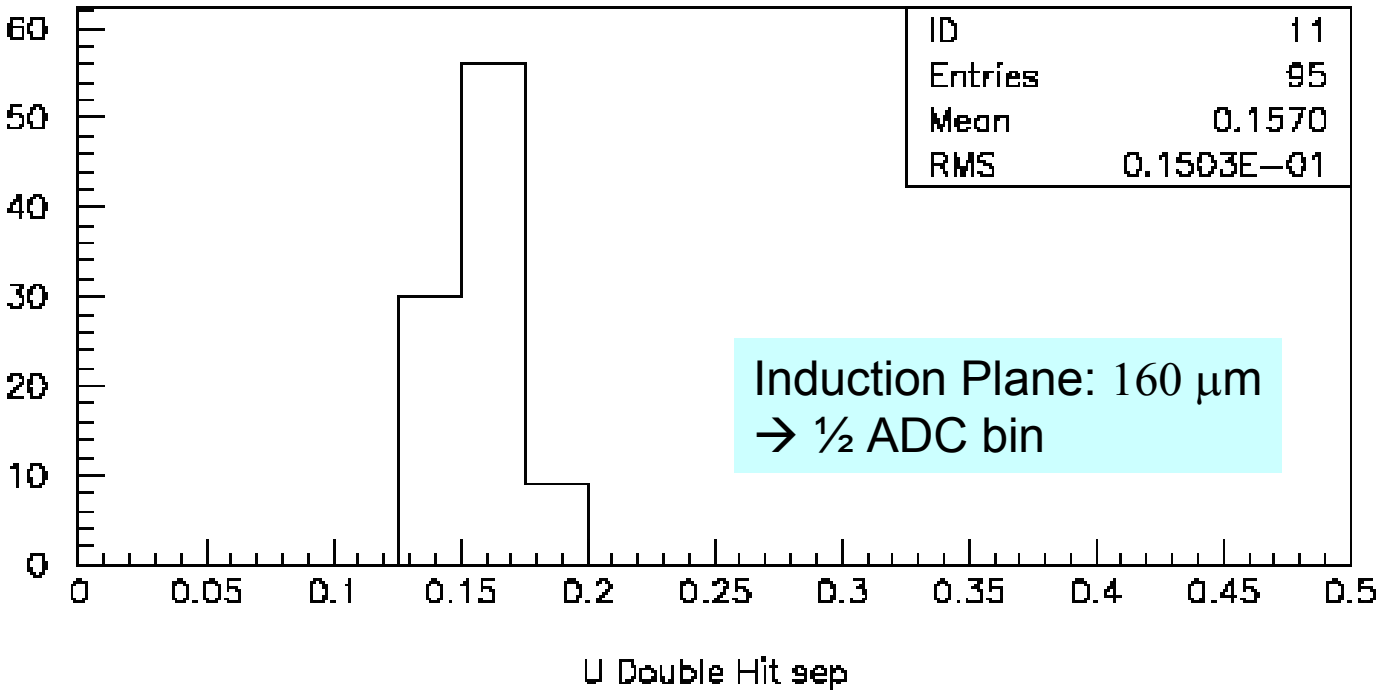
- Count the number of + and – ADC bumps (N^+, N^-)
  - ➢ If $N^+ > 1$ or $N^- > 1$, fit multiple hits
  - ➢ If $N^+ = N^- = 1$ ← Single hit or close double hit
    - Fit 1 hit
    - If χ^2/dof > 2, fit 2 hits
      - – Declare double hit if
        - » χ^2(2 hit) < χ^2(1 hit), and
        - » $MIPS_1 > 0.5$ and $MIPS_2 > 0.5$
      - – Use 1 hit fit if 2 hit fit fails

ArgoNeuT

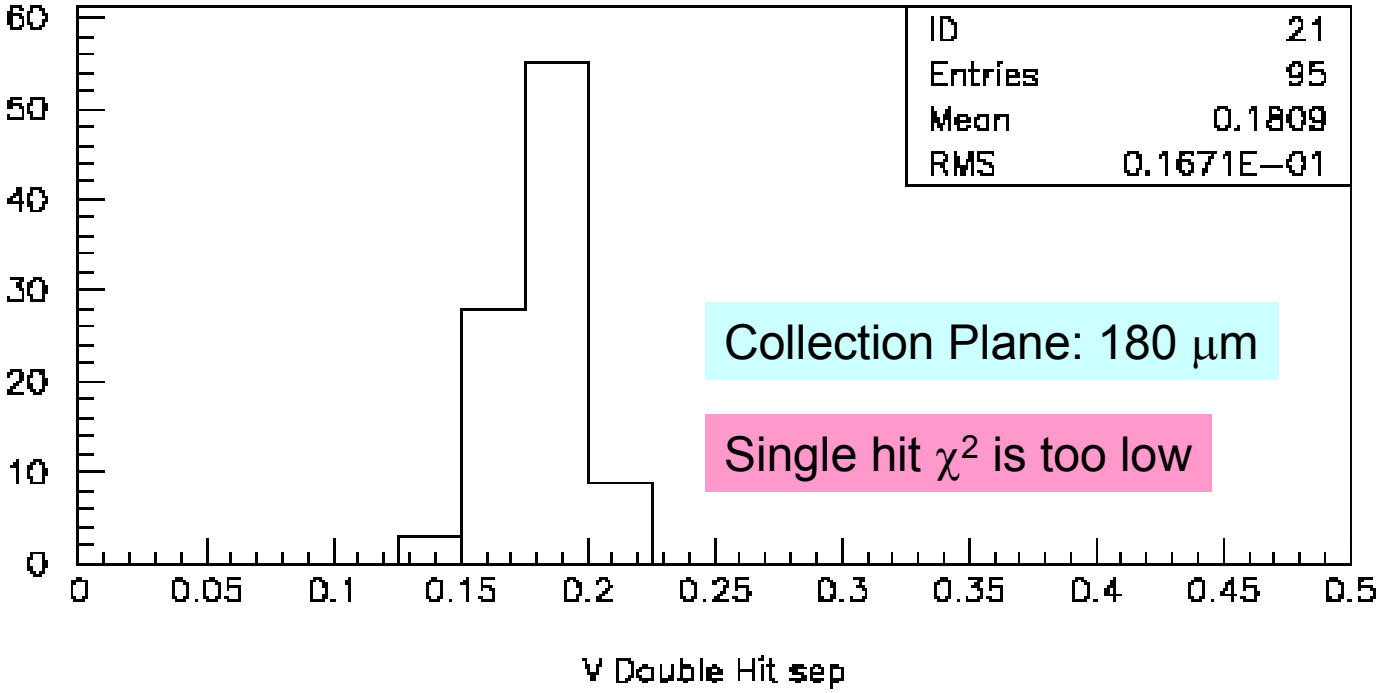
Reconstructed Hits



Double hit separation = 0.020 * δUV



Induction Plane: 160 μm
→ ½ ADC bin

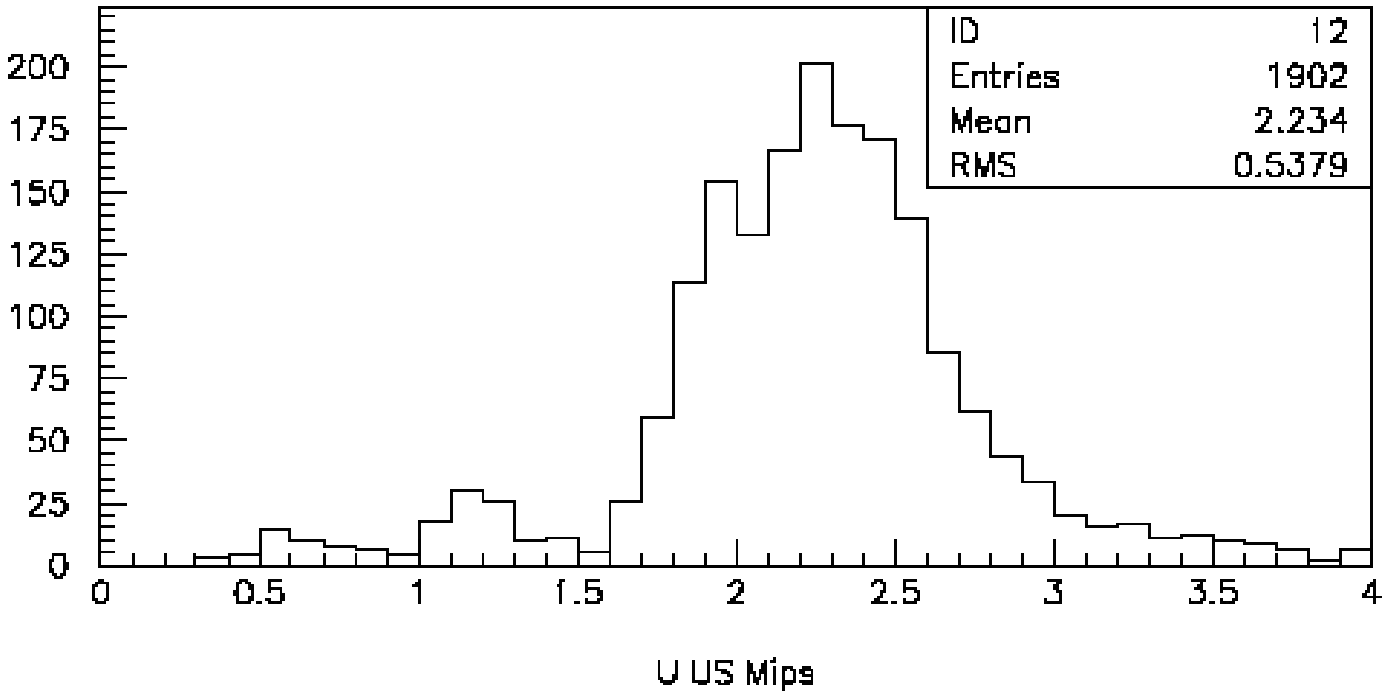


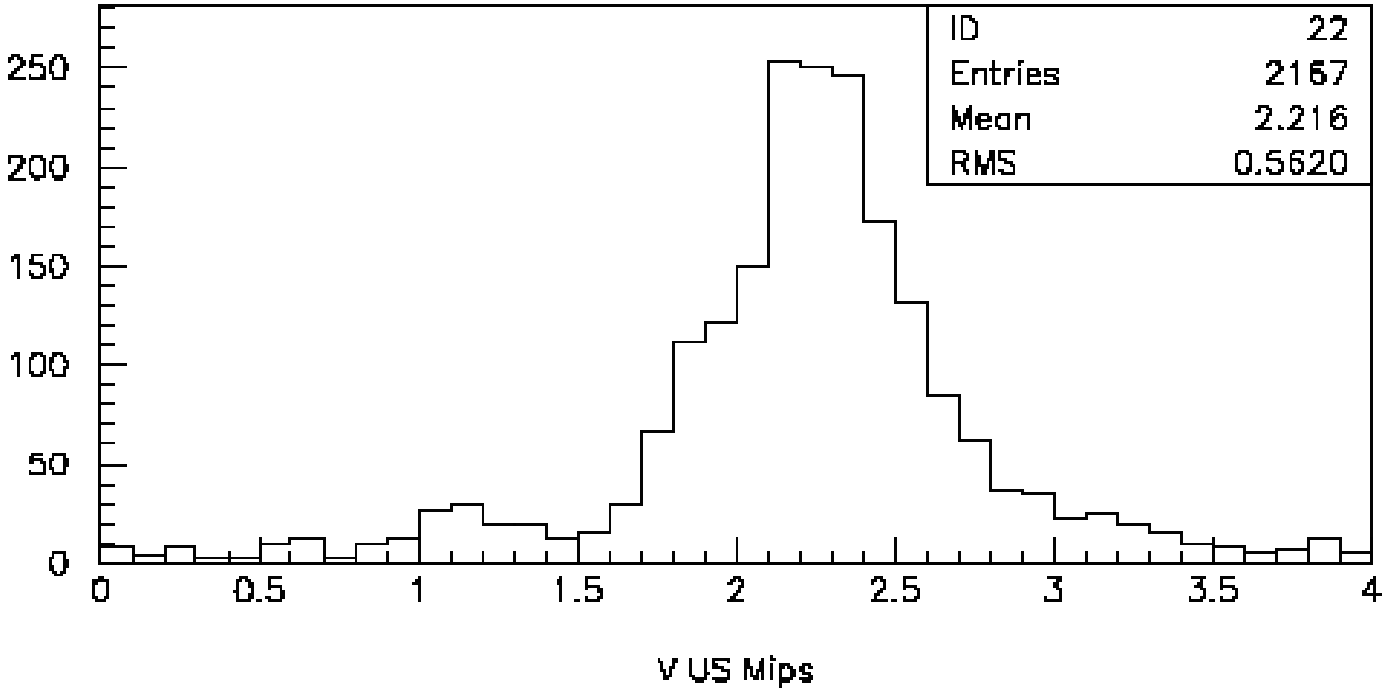
Collection Plane: 180 μm

Single hit χ^2 is too low

ArgoNeuT

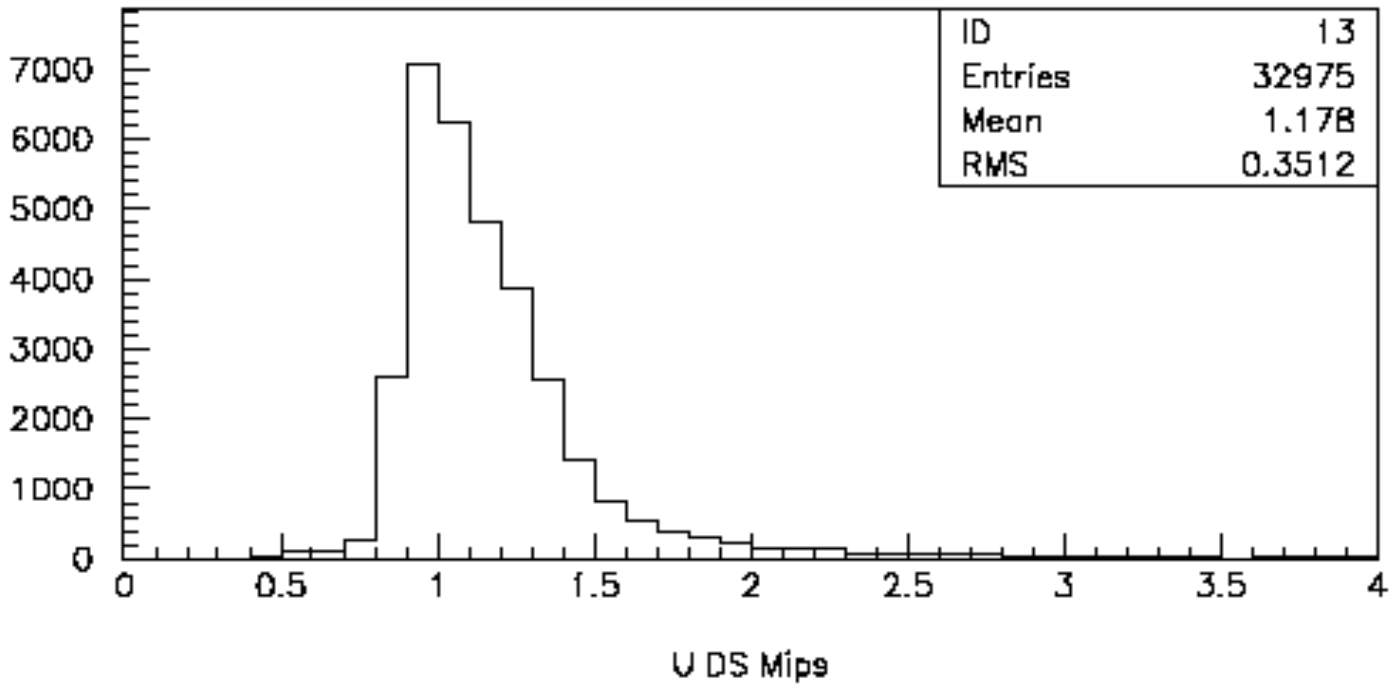
Un-corrected MIP's for all hits upstream of the first double hit plane

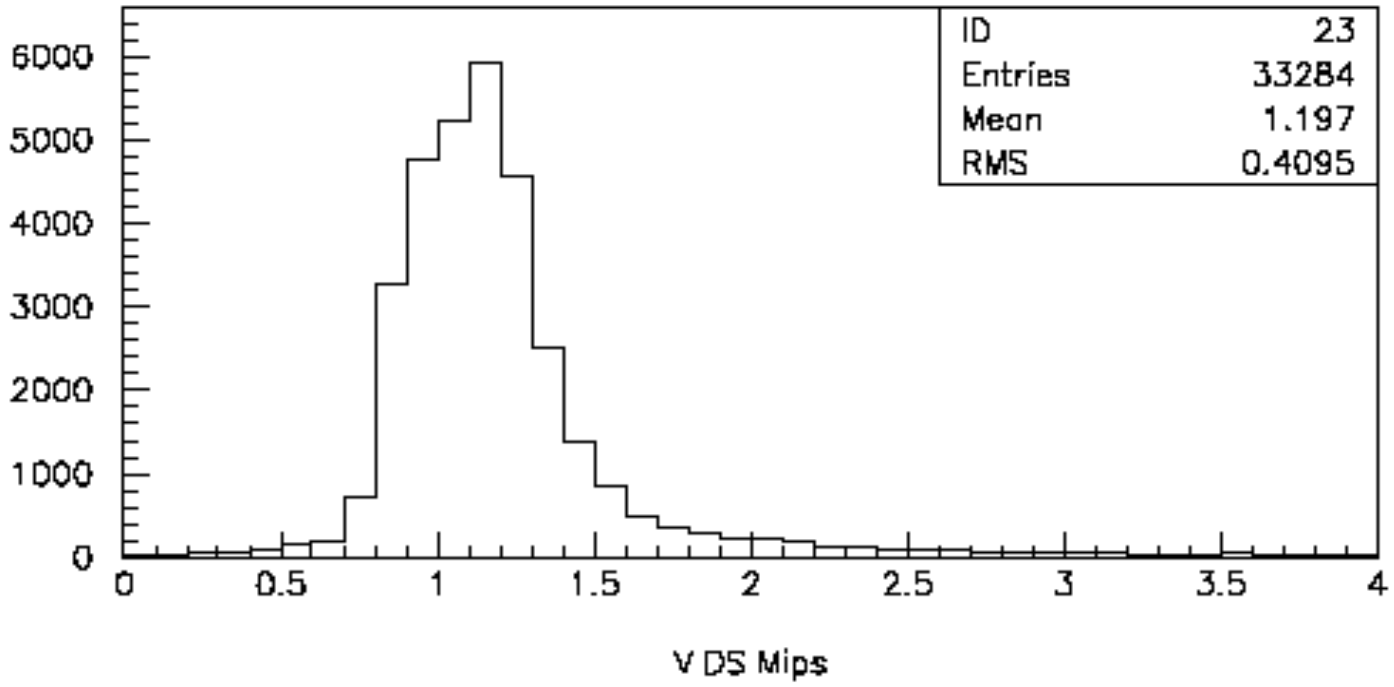




ArgoNeuT

Un-corrected MIP's for all hits downstream of the first double hit plane





ArgoNeuT

Summary & Plans

- A ~small set of parameters should allow distinguishing tracks at various angles during hit reconstruction
  - Deconvolution filter, hit fit weight, ~10? library shapes
- Excellent 2 hit resolution in drift direction for small track dip angles
  - 2 hit resolution is ~2x the single hit resolution
- Next
  - Finish defining library shapes
  - Parameterize hit resolution vs dip angle
  - Develop π^o identification